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Beyond promotion-based store switching: Antecedents and patterns of systematic multiple-store

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Abstract

In this paper, we demonstrate that single-purpose multiple store shopping is not only driven by opportunistic, promotion-based motivations, but may also be part of a longer term shopping planning process based on stable store characteristics. We find that consumers may systematically visit multiple stores to take advantage of two types of store complementarity. In the case of ‘fixed cost complementarity’, consumers alternate visits to high and low fixed cost stores to balance transaction and holding costs against acquisition costs. ‘Category preference complementarity’ occurs when different stores offer the best value for different product categories. Tying these multiple store shopping motivations to characteristics of grocery stores leads to interesting new insights into the nature of spatial retail competition.

Key words: multiple store shopping, store choice, spatial competition

1. Introduction

One of the most important trends characterizing today's grocery retail business is the massive rise in multiple store patronage (Kahn & McAlister, 1997). Rather than passively revisiting the same store – out of habit or due to an aversion to change - consumers actively exploit the opportunities offered by a differentiated retail environment by visiting two or more stores on a regular basis. In fact, strictly store loyal consumers have become the exception rather than the rule. A recent survey by Progressive Grocer (2004) indicates, for instance, that 75% of all grocery shoppers regularly visits more than one store each week (Stassen, Mittelstaedt & Mittelstaedt, 1999). Similar figures are reported in Drèze and Vanhuele (2003) and Fox and Hoch (2004).

The marketing literature has typically viewed grocery store switching as evidence of opportunistic cherry picking behavior, consumers switching stores to benefit from temporary promotional offers (Lal & Rao, 1997; Bell & Lattin, 1998; Drèze, 1999; Fox & Hoch, 2004). There is a growing belief, however, that multiple store shopping cannot be ascribed to price promotions alone (Popkowski-Leszczyc & Timmermans, 1997; Krider & Weinberg, 2000). First, the stability and regularity of multiple store shopping patterns reported in recent papers does not fit in with the picture of cherry picking consumers selecting stores on the basis of temporary 'best deals' (Galata, Bucklin & Hanssens, 1999; Rhee & Bell, 2002). Second, the fraction of consumers who decide where to shop on the basis of feature ads is found to lie in the 10-35% range (Urbany, Dickson & Kalapurakal, 1996; FMI 1993)- far below the fraction of shoppers who regularly visit multiple stores (about 75%, see above). Empirical evidence that sales promotions induce store switching and enhance store sales also remains limited (Rhee & Bell, 2002; Srinivasan, Pauwels, Hanssens & Dekimpe, 2004)¹. This suggests that consumers may systematically visit multiple stores for reasons other than promotional offers.

¹ One possible explanation is that consumers select a set of stores based on the expected basket price (including promotions) and then visit these stores repeatedly, (re)allocating their actual purchases over these stores at a given point in time depending on deals available at that time. Even so, this explanation would require consumers to figure out what is on deal in each store prior to shopping, and should lead to promotion-based shifts in category sales across stores.

In this paper, we study non-promotional motives for multiple store shopping. To improve our understanding of systematic multiple store shopping (MSS) and its implications, we develop a formal model of consumer shopping behavior. The model integrates insights from the marketing and geographical literature on shopping behavior. In addition to shopping costs, we explicitly account for differences in fixed and variable shopping benefits between different stores. Next, we do not only concentrate on store choice decisions but also incorporate related shopping decisions, such as shopping frequency, shopping trip organization, and category allocation decisions.

Our paper contributes to the available literature in several ways. We offer two main substantive insights. First, we show that, even in the absence of temporary promotional offers, consumers may have good reasons to patronize more than one grocery store. More specifically, we demonstrate that consumers may systematically allocate their purchases over two or more stores to take advantage of two types of store complementarity: (i) *fixed cost complementarity* (stores with the lowest fixed costs - such as transportation and in-store costs – have higher variable costs) and/or (ii) *category preference complementarity* (one store is preferred for a subset of categories, another store for the remaining categories). Second, we link consumers' motives for visiting multiple stores with their shopping trip organization, i.e., whether different stores are visited on the same or separate shopping trips. This, in turn, will affect how category purchases are allocated across stores.

From a managerial perspective, we shed new light on the nature of spatial competition between retail chains. Based on estimated shopping cost functions obtained from a scanner panel data set, we derive the spatial distribution of consumers' optimal (single or multiple store) shopping patterns for various competing store chains. We show how the type and degree of complementarity between these chains may lead to distinct competitive patterns: 'Winner-Takes-All', 'Partial Eclipse', or 'Jig-Saw' Competition, in which retailers either fight for the shoppers' entire basket, or try to secure a proper share of their grocery spending.

The discussion is organized as follows. We first present a conceptual framework describing the shopping decision process. Building on this framework, section 3 specifies the mathematical shopping decision model, with its implied shopping pattern alternatives and the conditions under which they prevail. An empirical model is presented in section 4, and implications for retail competition are

discussed in section 5. Section 6, finally, provides an overview of the major conclusions, limitations, and interesting areas for future research.

2. Related literature

Our paper builds upon two main streams of literature: the marketing-based literature on store choice models, and the predominantly geographical oriented literature on multipurpose shopping and spatial interaction models.

Marketing papers on store choice mostly concentrated on single purpose shopping, where consumers face a choice between competitive stores that offer essentially similar assortments. These papers model the consumer's selection of a retail outlet at a given point in time, typically assuming that consumers select the store that provides the maximum shopping utility and that they will assign their entire shopping basket to this store (Messinger & Narasimhan, 1997; Bell, Ho & Tang , 1998). Within this setting, shifts in store patronage over time are especially related to changes in the consumer's shopping list and other situational factors - such as promotions – that affect the consumers' variable shopping costs.

A few marketing papers have relaxed this focus on single store selection. Lal and Rao (1997) and Galata et al. (1999), for instance, developed predictive and normative models of how promotional price cuts may affect store format selections. In this framework, part of the consumers may visit EDLP as well as HiLo stores on a regular basis, to combine advantages of lower regular prices (EDLP stores) with occasionally offered, sharp promotional price cuts (HiLo stores). However, as specials are typically offered at random points in time, and given that empirically observed store switching effects are not overwhelming, additional forces must underlie systematic multiple store visits for groceries. In an exploratory analysis of consumers' shopping behavior across and within retail formats, Fox, Montgomery and Lodish (2004) find that - besides promotions – stable store format features such as assortment and accessibility do affect multiple store patronage. Their results also suggest that consumers' preferences for alternative formats are interrelated. Based on these findings, the authors

call for research that sheds more light on the complementarity and substitutability of stores in different formats, accounting for consumers' 'higher-order shopping strategies'.

The latter issues received widespread attention in the geographically oriented literature on multi-purpose shopping (Ghosh & McLafferty, 1984; Ingene & Ghosh, 1990; Dellaert, Arentze, Bierlaire, Borgers & Timmermans, 1998). In these papers, multiple store shopping is seen as the outcome of shopping location choices, taking into account more than one shopping purpose or need. Often, not all locations can satisfy the full set of purchase needs (e.g. groceries as well as shoe repair services). In such cases, purchases may be systematically allocated to different shopping locations depending on whether other, complementary shopping tasks have to be fulfilled on the same shopping trip. For instance, consumers will buy their groceries on a different (often more remote) location when they also need to visit a shoe repair shop. Buying frequently purchased products such as groceries at different locations allows to reduce transportation and holding costs, and hence minimize overall shopping costs.

A key question is to what extent these insights from multipurpose studies remain relevant when consumers have only a single purpose – buying groceries. It should be recognized that, in the above-mentioned papers, multiple store shopping arises because some locations only carry a subset of product categories. While this assumption is valid for multi-purpose shopping trips, it may not hold for single-purpose shopping trips. An interesting study by Krider and Weinberg (2000) indicates that a trade-off between fixed and variable shopping costs can also motivate consumers to visit multiple stores in a single purpose shopping context - where stores offer the same types of products. To reduce overall shopping costs, consumers may decide to buy perishable (high holding cost) products predominantly in nearby (possibly less preferred) stores, while fulfilling the bulge of their other product needs in more distant (but more preferred) stores. Yet, in Krider and Weinberg's analysis, price/quality differences across chains are the same for all categories and only the effect of *storage cost differences* between categories intervenes, leaving other potential motivations for MSS uncovered.

In sum, while providing relevant insights, the literature to date leaves us with a challenging research issue: to explore the reasons behind, and the strategic consequences of, systematic multiple

store shopping in a single purpose context (grocery shopping), where consumers face a variety of store chains with the same categories but with different benefits and costs.

3. Single-purpose multiple-store shopping

3.1. Conceptual framework

Figure 1 summarizes our conceptual framework, which extends the available literature in several ways. In line with Bell et al. (1998), we assume that consumers maximize overall (fixed and variable) shopping utility when making their shopping decisions. However, while Bell et al. (1998) focus on store choice, we extend their analysis by including additional shopping decisions affecting the attained utility level (see right panel of Figure 1):

- The selection of a *shopping pattern*, where we distinguish between the following three generic options²:
 - (I) *Single Store Shopping Pattern*: here, the consumer always visits the same store
 - (II) *Separate Store Shopping Pattern*: the consumer patronizes multiple stores, but visits only one store on each shopping trip. A trip refers to one displacement by a consumer to buy groceries, usually starting from and returning to his home.
 - (III) *Combined Store Shopping Pattern*: the consumer patronizes more than one store on each shopping trip.
- The selection of the *specific store(s)* to be visited.
- The determination of the number of shopping trips for each store, i.e. store specific *shopping frequency*.
- The *allocation of category purchases* over stores.

² In reality, stable shopping patterns may consist of a mix of these generic patterns, such as a combination of separate and combined multiple store shopping trips. For simplicity of exposition, the discussion below concentrates on the three ‘pure’ shopping patterns (either single, separate or combined visits). Similar analyses for mixed shopping patterns (consumers alternating between separate and combined visits) point out that the underlying motivations are a combination of those for ‘pure’ patterns, see also note 6 below.

When making these decisions, consumers trade off several types of shopping benefits and costs (see central box in Figure 1). Based on the spatial interaction model literature (Ghosh & McLafferty, 1984; Bawa & Ghosh, 1999), we specify the consumer's shopping decision process as a cost minimization problem, and include three types of *costs*: (i) transaction costs or fixed shopping costs. These are incurred each time a shopping trip is made and consist of transportation and in-store costs. Transportation costs stem from the time and effort to go to the store, typically related to store distance. In-store costs refer to time costs of walking through the aisles and waiting at the checkout (ii) acquisition costs or variable shopping costs (the amount to be paid to acquire the products), and (iii) handling and holding costs (costs of handling and storing the products at home).

In addition, building upon the marketing-oriented shopping studies (Tang, Bell & Ho, 2001), we account for variable and fixed shopping *benefits*: (i) consumption benefits (the utility of consuming the products), and (ii) fixed in-store benefits (the pleasure derived from the shopping act which, for instance, is enhanced by store ambience and service level, Berman & Evans, 1999).

Given our interest in systematic multiple store shopping, we focus on equilibrium shopping patterns, based on *stable* benefits and costs (see Krider & Weinberg 2000; Galata et al., 1999; Ghosh & McLafferty, 1984; Ingene & Ghosh, 1990 and Bawa & Ghosh, 1999 for a similar approach). As indicated in the left panel of Figure 1, the level and importance of these benefits and costs will depend on store characteristics (such as size, accessibility, service level), product category characteristics (like demand and storage cost), and the interaction between them (e.g. store differences in assortment quality and variety for the required categories). Concentrating on these stable shopping factors allows us to isolate the phenomenon of MSS.

3.2. Shopping behavior model

In this section we model the consumer's shopping cost function. Let s be a store indicator, and p a product category indicator. Like Ghosh and McLafferty (1984), we assume that a consumer's

shopping pattern includes at most two stores ($s=s1,s2$)³. For simplicity of exposition, we also present our model and results for two product categories ($p=p1,p2$) - a condition that will be relaxed in the empirical section. Consistent with our focus on single-purpose shopping, we assume that each category can be bought in each store, thereby relaxing Ghosh and McLafferty's assumption that one of the product categories can be bought in one of the stores only.

Building on Ghosh and McLafferty's spatial interaction model, we propose the following expressions for the consumer's total shopping cost during a specified planning horizon (to avoid notational burden, we omit the consumer superscript):

For shopping patterns involving a single store $s1$ only (pattern I):

$$TC_{I,s1} = \sum_p [VC_{p,s1} D_p + S_p D_p / 2N_{s1}] + t_{s1} N_{s1} \quad (1a)$$

For consumers visiting two different stores ($s1$ and $s2$) on separate shopping trips (pattern II):

$$TC_{II} = [\sum_{s=s1,s2} (\sum_p (\alpha_{II,p,s} VC_{p,s} D_p + \alpha_{II,p,s}^2 S_p D_p / 2N_{s,p}) + t_s N_s)] \quad (1b)$$

For shopping patterns involving combined trips to stores $s1$ and $s2$ (pattern III):

$$TC_{III} = [\sum_p (\alpha_{III,p,s1} VC_{p,s1} D_p + \alpha_{III,p,s2} VC_{p,s2} D_p) + \sum_p S_p D_p / 2N_{s1s2} + t_{s1s2} N_{s1s2}] \quad (1c)$$

where

TC = total shopping cost per period (i.e., the consumer's planning horizon)

$\alpha_{p,s}$ = fraction of category p 's demand purchased in store s

$VC_{p,s}$ = net variable shopping cost per unit for category p in store s

D_p = demand per period for category p

S_p = storage cost per unit of category p per period

$N_s (N_{s1s2})$ = number of shopping trips per period to store s (combined trips to stores $s1$ and $s2$)

$N_{s,p}$ = number of shopping trips per period to store s on which category p is purchased

³ In this expression, we assume that the consumer considers stores $s1$ and $s2$. In fact, a similar expression can be formulated for any pair of stores, consumers then (i) for each store pair $\{s1,s2\}$, deciding upon the best shopping pattern (optimal levels of N_{s1} , N_{s2} , N_{s1s2} and α_{s1} , α_{s2} minimizing expression (1) for that pair) and (ii) comparing these 'best patterns' across store pairs. In the remainder of the mathematical derivations, we will focus on the cost expressions involving a store pair $\{s1,s2\}$.

$t_s(t_{s1s2})$ = net fixed shopping cost per trip to store s (per combined trip to stores s1 and s2),

and the subscripts I, II and III refer to single, separate, and combined shopping patterns, resp.

In each of these expressions, three cost types intervene:

- The first is the *total net variable shopping cost* over the planning period, which depends on the consumer's category demand (D_p) and on how category purchases are allocated across stores ($\alpha_{p,s}$). The net variable shopping cost for a *unit* of category p in store s ($VC_{p,s}$) is specified as the difference between price ($P_{p,s}$) and quality/consumption benefits ($Q_{p,s}$) per unit of category p bought in store s.
- The second term captures the total *holding costs* over the planning period. If all category purchases are made in a single store s (pattern I), the average inventory level is equal to $D_p/2N_s$ and the total holding cost for the category amounts to $S_p * (D_p/2N_s)$ ⁴. With combined shopping patterns (pattern III), all categories are still purchased during the same shopping *trip*, such that the holding cost expression remains the same as for the single store strategy. In case of separate store visits, however, the holding cost function becomes more complex. Specifically, when only a fraction $\alpha_{p,s}$ of category p's demand is purchased in store s, holding costs for these purchases have to be corrected for (i) the lower amount bought in store s ($\alpha_{p,s} * D_p$ instead of D_p), and (ii) the fact that the acquired products have to be stored during only a fraction $\alpha_{p,s}$ of the planning period. Like Ghosh and McLafferty (1984), we further rely on the assumptions that (i) customers who visit different stores on separate shopping trips deplete the inventory of one store's products before making purchases of the same product category in a different store, and (ii) the number of store visits to one store is an integer multiple of the number of visits to the other. Under these assumptions, holding costs per category and store in the separate store shopping strategy (II) amount to $\alpha_{p,s}^2 * S_p * D_p / 2N_{s,p}$ ⁵ (Ghosh & McLafferty, 1984).

⁴ Like Krider and Weinberg (2000), we specify unit holding cost as independent of purchase price. For groceries, this seems like an acceptable assumption, since (i) price differences between stores and (ii) financial investments in these products (absolute price levels) are low. Note that our S_p does vary by product category. Allowing holding costs to vary with store price differences would make the derivations more complex, but would not alter the essence of our findings.

⁵ Unlike Ghosh and McLafferty, we use $N_{s,p}$ (the number of visits to store s on which category p was purchased) rather than N_s (total number of visits to store s) in the denominator of the expression. The reason is that when purchases of several categories are allocated to more than one store (a situation not considered by Ghosh and McLafferty), consumers must align the timing of store visits across the different categories, and may find it optimal not to purchase the category on each visit to the store. This will be discussed in more detail below.

- The third term represents *the total net fixed shopping costs*, specified as the number of trips (N_s) times the net fixed costs incurred per trip (t_s). The latter is obtained by subtracting the in-store benefits from the transportation and in-store cost of one visit. The fixed cost of a combined trip to stores $s1$ and $s2$ (t_{s1s2}) is a function of the fixed cost of a trip to each of the separate stores. Given that the transportation cost for a combined trip comprises the cost of a ‘one-way journey’ to $s1$ and $s2$ plus the cost of travelling from $s1$ to $s2$, combined shopping trips may allow to reduce transportation costs, especially when the distance between both stores is small.

In brief, shopping cost functions (1a)-(1c) have three distinguishing features. First, they combine benefits and costs into ‘net costs’, thereby generalizing previously used cost functions in the spatial interaction model literature. Second, they allow for single as well as multiple store shopping in a single purpose (grocery) context where all categories are available in all stores. Third, in case of multiple store shopping, they allow for category purchases to be allocated to different stores, which may be visited on separate or combined shopping trips⁶.

Henceforth, we use the shorter terms ‘fixed costs’ and ‘variable costs’ to denote the *net* cost level obtained after subtraction of in-store and consumption benefits. Moreover, whenever confusion is possible, we use *unit* fixed cost to denote the fixed cost per shopping trip to a store, and *total* fixed cost to denote the fixed costs over the planning horizon. Similarly, the terms *unit* variable cost and *unit* holding (or storage) cost refer to the cost for one unit of a category in a store, and *total* variable cost’ and *total* holding cost to the costs over the entire planning period.

3.3. Optimal shopping pattern selection

⁶ In principle, our model can accommodate mixed patterns, in which consumers visit multiple stores on separate and combined shopping trips. To illustrate this, integration of the three cost functions and replacement of $\alpha_{p,s1}$ by $\delta_{p,s1}$ (based on the proof of result 2a below) leads to the following overall cost function:

$$TC = \left[\sum_s \sum_p \alpha_{p,s} VC_{p,s} D_p + \sum_s \sum_p \alpha_{p,s}^2 S_p D_p \right] / 2N_s + \sum_s t_s N_s + \sum_p \alpha_{p,s1s2} (\delta_{p,s1} VC_{p,s1} D_p + (1 - \delta_{p,s1}) VC_{p,s2} D_p) + \sum_p \alpha_{p,s1s2}^2 S_p D_p / 2N_{s1s2} + t_{s1s2} N_{s1s2}$$

where

$\delta_{p,s1}$ = indicator variable, equal to 1 if – on a combined trip to stores $s1$ and $s2$ - category p is bought in store $s1$, and equal to 0 if bought in store $s2$.

$\alpha_{p,s1s2}$ = the fraction of category p ’s demand per period purchased on combined shopping trips to $s1$ and $s2$.

Values of $\alpha_{p,s1s2}$ between 0 and 1 correspond to mixed shopping strategies, in which a fraction $\alpha_{p,s1s2}$ of category purchases are made on combined shopping trips, and a fraction $(1 - \alpha_{p,s1s2})$ on separate visits to store $s1$ or $s2$.

In this section, we derive conditions under which alternative shopping patterns are optimal. We assume that consumers select the shopping pattern with the lowest total shopping cost as specified in (1). To identify this optimal shopping pattern, we first determine optimal shopping frequencies (N_s or N_{s1s2}) and optimal category allocations ($\alpha_{p,s}$) for each type of shopping pattern. We then substitute the resulting expressions into the total cost functions.

Appendix 1 provides details on the derivations. The results are summarized in Table 1, which presents optimal store visit frequencies (first column), optimal category purchase allocations (second column), and minimum total costs (third column). In these ‘minimum cost’ expressions, the first term captures the fixed plus holding costs, while the remaining terms cover the total variable shopping costs. These analytical expressions for optimal costs allow us to identify under which circumstances different types of MSS may prevail⁷. Specifically, the potential for MSS critically depends on (see Figure 2 for an overview):

- the stores’ unit fixed costs, which can be the (i) same or (ii) different
- the pattern of ‘category-specific store preferences’, measured as category differences in variable costs weighted by the inverse of holding cost (for a formal definition see Table 2). Three possibilities arise: (i) uniform category-specific store preferences (one store offers the same weighted variable cost advantage over the other store for all categories), (ii) category preference asymmetry (one store is preferred over the other for both categories, but the weighted cost advantage is larger for one category than for the other), and (iii) category preference complementarity (one store is preferred over the other for one product category, the other store offers more favorable conditions for the second category).

⁷ When considering the cost expressions in detail, two points have to be made on the separate visit strategy. First, for our model to be meaningful, the number of shopping trips for one store must be an integer multiple of that for the other store (see Ghosh and McLafferty for a similar requirement) – a condition that may require deviations from the number of shopping trips in column 1. Second, the optimal category allocations in the second column of Table 1 are obtained for each product category independently (see Appendix 1 for details). If, however, these results indicate that purchases of both categories should be spread across stores (situation IIc in the table), further adjustments are needed to align the timing of store visits and the associated purchase allocations across categories. It follows that, for the separate store strategy, especially for the case where each category is adopted in both stores, the costs in Table 1 constitute a lower bound on the true optimal costs of the separate visit strategy. This is of no consequence for the remainder of this section, where we mainly focus on necessary conditions for this strategy to be optimal. In our simulation analyses in the next section, we will explicitly incorporate these regularity conditions when comparing cost levels across shopping strategies, as explained in Appendix 3.

In the sections below, we show how these store pair characteristics determine whether single store shopping only (Result 1; cases 1, 2 and 3 in Figure 2), single or separate store shopping (Result 2; case 4 in Figure 2) or each of the three shopping patterns (Result 3; cases 5 and 6 in Figure 2) may prevail and discuss necessary conditions as well as underlying intuitive motivations for MSS.

Result 1 (Single store shopping only)

Result 1a: *If stores have no category preference complementarity and the same unit fixed cost (cases 1 and 3 in Figure 2), consumers will always prefer a single store shopping pattern.*

Proof: Let store s_1 be preferred over s_2 for both categories. Variable shopping costs of separate and combined shopping strategies can in this case never be lower than the variable shopping costs when only s_1 is visited. Moreover, with equal unit fixed cost for both stores ($t=t_{s_1}=t_{s_2}$), holding plus fixed shopping costs when only store s_1 is visited, will always be lower than

(i) those with separate visits to s_1 and s_2 :

$$\sqrt{2t (S_{p1}D_{p1} + S_{p2}D_{p2})} \leq \sqrt{2t (S_{p1}D_{p1}\alpha_{II,p1,s1}^2 + S_{p2}D_{p2}\alpha_{II,p2,s1}^2)} + \sqrt{2t (S_{p1}D_{p1}(1-\alpha_{II,p1,s1})^2 + S_{p2}D_{p2}(1-\alpha_{II,p2,s1})^2)} \quad \text{and,}$$

(ii) those with combined visits to s_1 and s_2 :

$$\sqrt{2t (S_{p1}D_{p1} + S_{p2}D_{p2})} \leq \sqrt{2t_{s1,s2} (S_{p1}D_{p1} + S_{p2}D_{p2})}$$

as $t_{s1s2} > t$ when stores are situated on different locations.

Hence, if one store is preferred over the other for all categories, buying all products in this store provides the lowest total variable costs. Given that both stores have equal unit fixed costs, this minimizes total shopping costs.

Result 1b: *If stores have uniform category-specific store preferences, (cases 1 and 2 in Figure 2), consumers will always prefer a single store shopping pattern.*

Even when fixed unit costs differ across stores, consumers will rule out MSS patterns as long as category-specific store preferences are uniform across categories. As indicated below in result 2a, combined trips are never an option with uniform category preferences. Moreover, Appendix 2 shows that, with uniform category preferences, the total shopping cost of the *separate* strategy becomes a

weighted average of those for the single store strategies, and can - therefore - never be lower than each of them.

Result 2 (Single or Separate store shopping)

Result 2a: *Single or separate store shopping patterns will always be preferred over combined shopping patterns when there is no complementarity in category preferences between the stores (cases 1 to 4 in Figure 2).*

Proof: From result 1, we already know that consumers will always prefer a single store shopping pattern when (i) category-specific store preferences are uniform across categories (case 1 and 2) or (ii) when category-specific store preferences are asymmetric but fixed store shopping costs are the same (case 3). Result 2a adds that even when fixed costs differ and category preferences are asymmetric (case 4), the combined visit pattern will entail higher total costs than single as well as separate store shopping patterns. This is a direct result of the fact that - when both stores are visited on the same shopping trip - category purchases will exclusively be made in the most preferred store. Optimal category allocations are found by computing the first order derivative of the total cost function (equation (1c)) with respect to $\alpha_{p,s1}$, leading to: $VC_{p,s1}D_p - VC_{p,s2}D_p$. As this expression does not depend on $\alpha_{p,s1}$, boundary solutions are optimal. Hence, products for which variable costs are lower in store s1 will be exclusively bought in this store ($\alpha_{p,s1}=1$), and vice versa. It follows that, unless there is category preference complementarity, both categories would be assigned to the same store, and there would be no point in patronizing two stores on combined visits.

Result 2b: *If category-specific store preferences are asymmetric and stores differ in unit fixed costs (case 4 in Figure 4), then consumers may find it optimal to engage in a MSS strategy with separate store visits. A necessary condition is a ‘total cost conflict’: the high fixed cost store must have lower variable costs per unit.*

The proof is given in Appendix 2. The intuition is as follows. Let store s1 be preferred over s2 for both categories. If fixed shopping costs are higher for store s1 than for store s2 ($t_{s1} > t_{s2}$), consumers may be facing a ‘total cost conflict’ (see also Table 2 for a formal definition): exclusively visiting

store s1 would imply lower total variable costs, but higher total fixed costs plus holding costs than a single store strategy involving store s2.

In such a setting, the *separate* store strategy constitutes an ‘intermediate’ option between each of these single store strategies, and derives its interest from category preference asymmetries. Its total variable shopping costs hold the middle between those for the single store s1 and the single store s2 strategies. Its total fixed plus holding costs will certainly exceed those of store s2 when visited alone. Yet, these costs *may* be lower than those when only s1 is visited, *if* the category with the high storage cost is less strongly preferred in store s1- the store with the higher fixed cost per trip. In this case, visiting both stores – instead of s1 or s2 alone – may entail two advantages. First, compared to visiting store s2 only, it allows to reduce total variable costs by transferring part of the basket to store s1. Second, by still visiting the low unit fixed cost store s2 for in-between purchases of the high holding cost category (the category with the weakest store preference for s1), it allows to keep fixed and holding costs lower than when only s1 is patronized.⁸ Henceforth, we refer to the conditions in result 2b as conditions for ‘fixed cost complementarity’.

Result 3: (Single, Separate or Combined store shopping)

Result 3a: *If stores exhibit category preference complementarity, each of the three shopping strategies may become optimal, whether fixed costs are the same or different (cases 5 and 6; Figure 2)*

The proof is given in Appendix 2. Let stores be such that s1 is preferred for category p1 and s2 for p2. We first consider the case where fixed shopping costs per trip are the same for both stores ($t_{s1} = t_{s2} = t$). The best single store strategy will be that with the lower total variable cost. This best single store strategy then has to be evaluated against the multiple store alternatives. It is clear that when both stores have the same fixed costs per trip, the single store strategy implies lower total holding plus fixed costs than any multiple store alternative. However, as the stores are preference complements, patronizing them both allows to purchase each category in the preferred store, thereby reducing the

⁸ Note that Krider and Weinberg’s (2000) results can be considered to be a special case of this MSS situation. Indeed, although Krider and Weinberg do not account for category preference complementarity (in their analysis, one store – the discounter – has lower net variable costs for all categories), category preference asymmetries are built in into their model through the holding costs. The higher storage cost for perishable products implies that with $VC_{p1,s1} - VC_{p1,s2} = VC_{p2,s1} - VC_{p2,s2}$, $I_{p2,s1-s2}$ can still be smaller in absolute value than $I_{p1,s1-s2}$ when $S_{p2} > S_{p1}$, p2 being the perishable product and s2 the more expensive regular store. As demonstrated by Krider and Weinberg and in line with result 2, this may lead consumers to buy part of their purchases in the preferred store s1 (in their case, the discounter), while making fill-in trips for the higher storage cost good (the perishable product) in the 2nd preference store (the regular store).

total variable cost component. Deciding upon single versus multiple store strategies therefore requires a trade off between the increase in total fixed plus holding costs and the decrease in total variable costs, from the multiple store strategy.

When fixed shopping costs differ between stores ($t_{s1} \neq t_{s2}$), the motives for selecting single, separate or combined visits become a mixture of the previous motivations. The introduction of differences in unit fixed costs will reinforce the appeal of strategy II if the high storage cost category is more strongly preferred in the store with the lower unit fixed cost. Conversely, if the high holding cost category is more strongly preferred in the high fixed cost store, the single and combined strategies become relatively more appealing.

How will consumers allocate their purchases across stores in these category-based MSS patterns? When both stores are visited on combined shopping trips, we showed under 2a that each product is purchased exclusively in the most preferred store. For the separate store strategy, allocation of category purchases will depend on the strength of category specific store preferences. When the difference in unit variable costs is sufficiently large, and the number of shopping trips to the preferred store sufficiently high, category p1 will be exclusively bought in store s1 even if store s2 is also visited by the consumer. We refer to this condition as ‘*strong category preference complementarity*’, a formal characterization is given in Table 2. Otherwise, consumers will purchase some portion of their category demand in the non-preferred store when that store is visited. This allows them to reduce total fixed plus holding costs – be it at the expense of higher total variable costs. The proof can be found in Appendix 2.

Result 3b: *The combined strategy will certainly be preferred over the separate strategy if the stores*

- *have strong category preference complementarity*
- *have the same unit fixed costs*

and

- *are located sufficiently close such that*

$$\sqrt{\frac{t}{t_{s1s2}}} > \frac{\sqrt{S_{p1}D_{p1} + S_{p2}D_{p2}}}{\sqrt{S_{p1}D_{p1}} + \sqrt{S_{p2}D_{p2}}} \quad (2)$$

Proof: Let stores be such that s_1 is preferred for category p_1 and s_2 for p_2 and that unit fixed costs are equal ($t_{s1} = t_{s2} = t$). With strong preference complementarity, we know that $\alpha_{p1,s1} = 1$ and $\alpha_{p2,s1} = 0$ for each multiple store strategy. Substituting this in the cost expressions from Table 1, we find that the separate store (II) and combined store (III) strategies yield identical total variable costs. The choice between these strategies is now completely driven by fixed and holding cost efficiencies. Specifically, a sufficient condition for the combined store strategy to be preferred over the separate store strategy is that

$$\sqrt{2tS_{p1}D_{p1}} + \sqrt{2tS_{p2}D_{p2}} > \sqrt{2t_{s1s2}(S_{p1}D_{p1} + S_{p2}D_{p2})}, \text{ which is equivalent to (2). We}$$

conclude that with strong preference complementarity, equal unit fixed costs and (2) satisfied, strategy III dominates strategy II.

Note that (2) is more likely to hold if the distance between the stores is small relative to their fixed in-store costs – implying that t_{s1s2} is small relative to t . The condition further reveals that with strong store preference complementarity, the separate store visit pattern (II) can never prevail if categories have the same ‘holding cost potential’. Indeed, if $S_{p1}D_{p1} = S_{p2}D_{p2}$, condition (2) becomes: $2t > t_{s1s2}$, a requirement that always holds.

4. Empirical Analysis

To empirically validate our theoretical developments and assess the parameters of the shopping cost functions, we estimate a multinomial logit model. The systematic utility components represent the total shopping cost per period for the shopping pattern (included in negative form, like in Bell et al. 1998): $-TC_{I,s_i}^h$ (for a single store pattern I involving store s_i), $-TC_{II,(s_i,s_j)}^h$ (for a separate-trip

pattern II involving the set of stores (s_i, s_j) , and $-TC_{III, (s_i, s_j)}^h$ (for selecting the set of stores (s_i, s_j) in a combined-trip pattern III):

$$P_{I, s_i}^h = \frac{\exp(-TC_{I, s_i}^h)}{\sum_{s_k} \exp(-TC_{I, s_k}^h) + \sum_{(s_k, s_l)} \exp(-TC_{II, (s_k, s_l)}^h) + \sum_{(s_k, s_l)} \exp(-TC_{III, (s_k, s_l)}^h)} \quad (3a)$$

$$P_{II, (s_i, s_j)}^h = \frac{\exp(-TC_{II, (s_i, s_j)}^h)}{\sum_{s_k} \exp(-TC_{I, s_k}^h) + \sum_{(s_k, s_l)} \exp(-TC_{II, (s_k, s_l)}^h) + \sum_{(s_k, s_l)} \exp(-TC_{III, (s_k, s_l)}^h)} \quad (3b)$$

$$P_{III, (s_i, s_j)}^h = \frac{\exp(-TC_{III, (s_i, s_j)}^h)}{\sum_{s_k} \exp(-TC_{I, s_k}^h) + \sum_{(s_k, s_l)} \exp(-TC_{II, (s_k, s_l)}^h) + \sum_{(s_k, s_l)} \exp(-TC_{III, (s_k, s_l)}^h)} \quad (3c)$$

where P_{I, s_i}^h , $P_{II, (s_i, s_j)}^h$ and $P_{III, (s_i, s_j)}^h$ are the probability for a single-store pattern with store s_i , a separate-trip pattern with stores (s_i, s_j) , and a combined-trip pattern with stores (s_i, s_j) resp.

4.1. Data and Operationalizations

Household and Store selection

To estimate the model, we use a scanner panel data set provided by GfK, comprising store visit and category purchase data for a random subsample of GfK's national household panel, over a period of 34 weeks. We include the top 12 national chains, which account for about 90 % of the market sales value and 87 % of total store visits, and retain only households for whom at least 80% of their grocery purchases occur in these stores. In addition, we restrict the consideration set to the seven stores most closely located to the household's home. Previous studies have demonstrated that consumers seldom include more than 7 stores in their consideration set (Fox et al., 2004: 6 store chains; Bell et al. 1998: 5 supermarkets; González-Benito et al., 2007: 7 stores), and that distance is the primary criterion for choice set delineation (Sinha, 2000; Fox et al., 2004, González-Benito et al., 2007). In all, our data set contains information for 906 households and 12 grocery chains (representing four different store formats).

Dependent variable: shopping patterns/ store set identification

The dependent variable in our model represents the household's stable selection of a shopping pattern (I single, II separate, or III combined) and - within each pattern - choice of a specific store (pattern I) or set of stores (pattern II and III). To operationalize this variable, we proceed as follows. First, as even the 'hard core loyal' consumers do occasionally patronize stores other than their primary chain, we characterize consumers as single store shoppers if they spend more than 80% of their shopping baskets at one and the same store. Consumers that do not meet that cut-off are classified as multiple store shoppers. Second, of these multiple store shoppers, consumers for whom the majority of store visits occur on combined trips (visits to more than one store on the same part of the day; see Fox & Hoch, 2005) are identified as combined-store shoppers. The remaining households are typified as separate-store shoppers. Consistent with previous findings, we find that many consumers visit multiple stores on a regular basis (62 % of the consumers are classified as systematic multiple store shoppers, 78% of them do so predominantly on separate store visits). The data also demonstrate that the choice of shopping pattern is quite stable: over 80 % of the consumers selected the same shopping pattern in the first and second half of the data period, the remaining 20% changing from one multiple store shopping pattern to another.

Explanatory variables: Cost components

Variable Costs. To incorporate net variable shopping costs, we first classify the products in our data set into broader product category types (p), based on their (i) levels of demand (Sprott, Manning & Miyazaki, 2003; Dhar, Hoch & Kumar, 2001), (ii) importance of quality and perceived quality differences, and (iii) degrees of perishability/storability (Kridler & Weinberg 2000). Like Fader and Lodish (1990), and Dhar et al. (2001), we use these dimensions to distinguish *specialties* (low demand, and perishability, high perceived quality differences), from *fresh* categories (high demand, perceived quality differences and perishability), and *convenience* categories (low perceived quality differences and perishability) - the latter comprising both staples (high demand), and necessities (low demand)⁹. The products in our data set are classified into these 'generic' product category types by

⁹ An advantage of this classification (which is also in line with the typology of the FMI, 1995) is that it is based on intrinsic category and consumer characteristics, and not on more endogeneous measures that refer to the outcome of the shopping pattern choice process – such as

two independent experts, yielding high inter-expert reliability. Examples of products in each category type are: canned food (convenience categories), health and beauty care (specialties) and fish/meat (fresh categories). For each of these product category types, a household's *demand* (D_p^h) is computed on a monthly basis and, to allow for meaningful aggregation across products, expressed in monetary units (at the product's average market price). Next, to obtain an estimate of store-specific *variable costs and benefits*, this demand variable is multiplied with the store's price index (PI_{p,s_i}) and variable benefit index for the product (VBI_{p,s_i}), resp. Given our purpose to explain stable shopping patterns, we include 'average' store characteristics over the observation period as explanatory variables in the model. The variable benefit index reflects both intrinsic quality and assortment, and is obtained as $VBI_{p,s_i} = QI_{p,s_i} * (Size_{s_i})^\kappa$, where QI_{p,s_i} is an indicator of the average quality of product p in store s_i (obtained from surveys among store shoppers; Testaankoop, 2000), $Size_{s_i}$ is a measure of store surface (see González-Benito et al., 2007, for a similar approach), and κ is a parameter (capturing the effect of assortment size on perceived variable benefits).

Holding costs. Like Krider and Weinberg (2000), we assume holding costs to be similar for convenience and specialty products, and lower than those of fresh goods. For lack of reliable storage cost measures, we treat both the base level (σ , representing the cost of one-month storage expressed as a percentage of the products' purchase value) and the differences between products (the storage cost index SI_p , set to one for convenience and specialty products, and estimated for fresh products) as 'parameters' in the model.

Fixed costs. Previous research has demonstrated that in-store benefits and costs are strongly related to type of store format. In-store search and waiting costs are typically higher for larger stores (such as hypermarkets), while in-store benefits tend to be lower for discount stores (which usually economize on store layout and customer service in order to keep product prices down). Based on these two dimensions – store size and price/quality position - four stylized types of grocery store formats

purchase frequency or exclusive store patronage /destination shopping. This is important, as we wish to *derive* optimal shopping patterns and store selection processes as outcomes of a given grocery setting. Given this objective, starting from a shopping behavior-based classification would be problematic.

can be distinguished (Kahn & McAlister, 1997; Sinha, 2000; Popkowski-Leszczyc, Sinha & Timmermans, 2000; González-Benito, 2004): (i) small & quality-oriented *supermarkets*, (ii) large & quality-oriented *superstores*, (iii) small & price-oriented *hard discounters*, and (iv) large & price-oriented *large discounters*. To capture the resulting differences in net fixed shopping costs between these store formats, we incorporate a parameter δ_f into the model, reflecting the in-store costs minus benefits for each store format f (where f is hard discounter HD, large discounter LD, superstore SS or supermarket SM). For combined shopping trips, we specify the total in-store shopping cost as a fraction v of the sum of in-store shopping costs for the two store visits. In the analysis below, we set v equal to $\frac{3}{4}$, which is half way between the two extremes of adding or averaging the in-store costs across stores. Sensitivity analysis reveals that the estimated parameters are rather insensitive to the specific level of v . In addition, to account for transportation costs associated with the trip to and from the store, we introduce the distance ($Dist_{s_i}^h$) between a household's residence and the store s_i .

Plugging these cost components into the optimal cost expressions derived in Table 1, the total costs for the single pattern (I), separate pattern (II) and combined pattern (III) in equations (3a), (3b) and (3c) take the following form:

$$TC_{I,s_i}^h = \sqrt{2(\sum_p \sigma SI_p D_p^h)(\sum_f \delta_f I_{f,s_i} + \beta Dist_{s_i}^h)} - \gamma \sum_p VBI_{p,s_i} D_p^h + \sum_p PI_{p,s_i} D_p^h \quad (4a)$$

$$TC_{II,(s_i,s_j)}^h = \sum_{s=s_i,s_j} \left(\sqrt{2(\sum_p \sigma SI_p D_p^h (\alpha_{p,s}^{II})^2)(\sum_f \delta_f I_{f,s} + \beta Dist_s^h)} + \sum_p PI_{p,s} (\alpha_{p,s}^{II}) D_p^h - \gamma \sum_p VBI_{p,s} (\alpha_{p,s}^{II}) D_p^h \right) \quad (4b)$$

$$TC_{III,(s_i,s_j)}^h = \sqrt{2(\sum_p \sigma SI_p D_p^h)((\sum_f \delta_f I_{f,s_i} + \sum_f \delta_f I_{f,s_j})v + \beta Dist_{s_i,s_j}^h)} + \sum_{s=s_i,s_j} \left[\sum_p PI_{p,s} D_p^h \alpha_{p,s}^{III,h} - \gamma \sum_p VBI_{p,s} D_p^h \alpha_{p,s}^{III,h} \right] \quad (4c)$$

where the variables and their operationalizations are summarized in Table 3, and the parameters to be estimated refer to storage cost (σ , and $SI_{p=fresh}$), the impact of distance on fixed shopping cost

(β), fixed in-store shopping cost minus benefits by format (δ_f for $f=HD, LD, SS$ and SM), the weight attached to variable benefits (as opposed to purchase price, γ), and the coefficient measuring the impact of assortment size on variable store benefits (κ).

4.2. Model estimation.

Parameter estimates are obtained by maximizing the following likelihood function:

$$LL = \sum_h \left[\sum_{s_k} y_{I,s_k}^h \ln(P_{I,s_k}^h) + \sum_{(s_k,s_l)} y_{II,(s_k,s_l)}^h \ln(P_{II,(s_k,s_l)}^h) + \sum_{(s_k,s_l)} y_{III,(s_k,s_l)}^h \ln(P_{III,(s_k,s_l)}^h) \right]$$

where y_{I,s_k}^i , $y_{II,(s_k,s_l)}^i$ and $y_{III,(s_k,s_l)}^i$ indicate whether the household exhibited a single pattern (I) to store s_k , a separate-store pattern (II) to s_k and s_l , or a combined-store pattern (III) to s_k and s_l , resp.

As can be seen from expressions (4a)-(4b)-(4c), the base level of holding costs σ on the one hand, and the parameters driving fixed shopping cost β and δ_f for $f=HD, LD, SS$ and SM ; on the other hand, are identified up to a scale factor only. We therefore set σ equal to one and estimate the levels of β and δ_f relative to this value of σ ¹⁰.

For multiple store shopping patterns, the fraction of a product's demand fulfilled in a store s_i (α_{II,p,s_i} and α_{III,p,s_i}) are themselves a complex function of the remaining model parameters (see Table 1). Model estimation is, therefore, carried out in two steps. In a first step, we set the level of α_{II,p,s_i} and α_{III,p,s_i} equal to .5, and obtain preliminary estimates for the model parameters. Based on these initial parameter values, we then calculate 'updated' values for α_{II,p,s_i} and α_{III,p,s_i} (note that for separate shopping trips where we do not have closed form expressions for optimal trip frequencies and category allocations, this updating requires an iterative procedure). In a second step¹¹, these new α_{II,p,s_i} and α_{III,p,s_i} are fed into equations (4b) and (4c), to obtain our final estimates.

¹⁰ In a later stage, additional data on the households' number of shopping trips are used to separate out the holding costs from the fixed shopping costs.

¹¹ Additional iterations did not entail further parameter changes.

Apart from estimating mean parameter levels, we are interested in assessing the stability of these parameters across households. However, given that we have only one observation (stable shopping pattern) per household, mixed-logit estimation does not provide us with reliable estimates for across-household variances (see Small, Winston & Yan, 2003 for a similar observation). We therefore adopt a bootstrapping procedure, re-estimating the model coefficients for 500 random samples of households from the original data set.

4.3. Estimation Results

Parameter estimates and Fit.

Table 4 summarizes the estimation results, for the full sample as well as for the bootstrapping procedure. As expected, distance significantly increases the fixed shopping cost ($\beta=.329$, $p<.01$). Conversely, the store's variable benefits, themselves influenced by assortment size ($\kappa=.104$, $p<.01$); significantly reduce this shopping cost ($\gamma=-1.325$, $p<.01$). The cost of holding fresh products reveals to be about 2.5 times that of other product types ($SI_{fresh}=2.519$, $p<.01$), a figure that makes intuitive sense. Fixed in-store costs (net of benefits) are highest for large discounters immediately followed by hard discounters, and are significantly lower for both superstores and supermarkets. This suggests that households' perceptions of fixed in-store costs are not primarily driven by time costs induced by store size, but strongly attenuated by ambience attributes like store atmosphere, cleanliness and friendliness -attributes on which superstores and supermarkets score highly. The estimated bootstrap coefficients are, on average, very close to the full sample coefficients, while revealing heterogeneity especially in in-store fixed costs of the hard discounters.

Table 5 reports net variable costs divided by storage cost, across category types for each chain. Note that this metric is crucial for assessing the presence of preference asymmetry or complementarity (see Table 2). As expected, these (weighted) net variable costs per unit are lowest in large discounters, which have come to carry large assortments of high quality products while maintaining low prices. Because of their high prices, supermarkets typically exhibit higher net

variable costs per unit than the two hard discounters for convenience products, but not for specialties and fresh products where their assortment or quality advantage may prevail. At the same time, stores within the supermarket format, as well as the two superstores, still show substantial variation in the appeal of their offer.

Benchmark models

To further assess the model's descriptive validity, we compare it with two benchmarks. Our first null model, M0, is a model with store constants only, estimated as the stores' share of visits in the market. A second benchmark model, M1, specifies the utility for a store set as the average utility of each of the two stores, this average utility being (minus) the total shopping cost of a single store shopping pattern. This second benchmark takes distance and store characteristics into account, but does not recognize store complementarity (e.g. the possibility to avoid fixed shopping costs by combining closely located stores, or to reduce variable shopping costs by selectively purchasing different categories in different stores). Comparison reveals that the full model (given by (3a)-(3c) and (4a)-(4c)) yields a significantly better fit: its loglikelihood ($ll = -2971.7$) and BIC (5991.1) being significantly higher (lower) than that of both benchmarks (M0: $ll = -3435.0$, BIC=6951.8; M1: $ll = -3013.5$, BIC=6074.6).

In the models above, each consumer is uniquely associated with his 'dominant' shopping pattern and store (set) over the 34 week period. Even though these shopping patterns appear to be stable over time, we conduct a robustness check. We divide the total observation period in a sequence of 4-week observations, and assess the consumers' shopping pattern in each of those periods. We then re-estimate the model using as the dependent variable the fraction of times a consumer exhibits a single, separate or combined store shopping pattern (instead of the original zero/one formulation). The resulting coefficients reveal highly similar to those reported in Table 4, supporting the robustness of the outcomes.

5. Implications

In this section, we illustrate the spatial competition between store chains implied by our estimated shopping cost model. To this end, we consider market areas in which consumers are uniformly distributed, and have access to two store chain outlets. Using the cost estimates for these chains we then determine, for given consumer demand characteristics ($D^h=8$, with expenditure shares of convenience, specialty and fresh products equal to .7, .1 and .2), consumers' optimal shopping patterns as a function of their distance to the stores. The results demonstrate that – depending on the type and strength of store complementarity and the distance between stores - three typical spatial competition patterns emerge: (i) winner-takes-all competition, (ii) partial eclipse competition and (iii) jig-saw competition. Figures 3-5 provide a graphical illustration of these competition patterns, which are discussed in more detail below. Note that spatial competition patterns can become somewhat more complex in real life situations, when for instance, more than two stores are located in the same trading area, stores are located closer (or farther away) from each other, or consumers differ on other aspects than distance to the store (e.g. socio-demographic and/or purchase behavior profile). Yet, the more simple cases displayed in Figure 3 to 5 clearly indicate that, depending on the type and strength of store complementarity, the competitive situation may range from a 'share-of-customer' to a 'share-of-wallet' rivalry.

Winner-takes-all competition. Figure 3 pictures the competition between Aldi (hard discounter) and Makro (large discounter), with stores located at a distance of 3.5 km, a realistic figure based on our data set. As can be seen from Table 5, there is no complementarity in category preferences between these stores (for each category, net variable costs of Makro are lower than those of Aldi), ruling out combined shopping patterns. In addition, while the Aldi-Makro combination may lead to a total cost conflict (variable costs being lower but in-store costs higher at Makro), differences in category-specific store preferences across categories are negligible (weak category preference asymmetry¹²), canceling out the possible advantages of separate store visits. It follows that there is little incentive for multiple store shopping, which results in 'Winner takes all' competition. Consumers patronize only one of both stores, and the spatial pattern is such that each format is the

¹² Since – in reality - variable cost differences will never be exactly the same for all product categories, this case represents a reasonable approximation of the 'different fixed costs-uniform category preferences' situation discussed above.

preferred alternative in its surrounding area, fighting for the complete wallet of consumers in the border zone¹³. Note that the size of these areas depends on store location: as the hard discounter (with higher variable costs) moves closer to the large discounter, its customer core will become smaller, more consumers shopping exclusively at Makro.

Partial-eclipse competition: Figure 4 illustrates, using the same between store distance of 3.5 km, the spatial distribution of optimal shopping patterns for Champion (supermarket) and Intermarché (large discounter). While there is no complementarity between these stores in category-specific store preference (Intermarché offering lower variable costs for all categories), the variable cost advantage of Intermarché is clearly much larger for convenience items than for other product categories (category preference asymmetry, see Table 5). Compared to the hard-large discounter combination discussed above, there is also a much larger difference in in-store fixed costs (lower for the supermarket Champion), leading to a more pronounced ‘total cost conflict’. This results in an interesting competitive pattern that we refer to as *Partial Eclipse Competition*. Within a concentric area around the supermarket, consumers allocate their entire grocery basket to that outlet. Conversely, customers located out of that area will prefer single format patterns to the large discounter. Exceptions are consumers in the ‘shield’ or ‘partial eclipse’ zone between the formats. Motivated by ‘fixed cost complementarity’, those consumers engage in MSS with separate visits to each store. This allows them to economize on total fixed plus holding costs by purchasing high demand or perishable categories from the small format during fill-in visits. At the same time, they allocate a large part of their basket to the format with the most favorable price/quality positioning, keeping total variable costs low. Hence, each format may compete for (i) an extension of its ‘exclusive’ trading area and/or (ii) a larger share of wallet from consumers in the MSS zone.

Jig-saw competition : Figure 5 represents the optimal shopping patterns for DelhaizeDeLeeuw (supermarket) and GBSuper (supermarket). As these stores are usually located quite closely together (same store format, competing for the same type of customers, see González-Benito, 2007), we set the between store distance at a low .3 km. While in-store fixed costs of these stores are much the same,

¹³ Note that this result is not in contrast with result 2b, which states that preference asymmetry and a total cost conflict are *necessary* conditions for separate store shopping to occur. These conditions are, however, not sufficient. As indicated in the discussion below result 2b, single store shopping patterns may still be optimal when cost advantages of the ‘compromise’ separate store strategy (lower variable costs than s2, lower fixed shopping costs than s1) are insufficient to bring total costs below the level of any of the single store strategies.

they differ in variable shopping costs. More specifically, DelhaizeDeLeeuw has higher variable costs for convenience items but a more appealing offer for specialty products compared to the rival supermarket GBSuper. These category preference *reversals* induce more complex competitive patterns, or *Jig-Saw Competition*, motivating some consumers to engage in either separate or combined multiple store shopping. While the stores' immediately surrounding area typically comprises single store shoppers, consumers in the area situated in-between the two store sites may engage in separate store shopping. For customers living farther away from the chain outlets, variable cost advantages of separate store visits may no longer compensate for the much higher transportation costs. Yet, when both stores are visited on the same shopping trip, additional transportation costs become relatively small. Customers in the border zone may therefore decide to visit both stores on combined shopping trips, implying that category purchases will be exclusively allocated to one of both stores. Sensitivity analysis reveals that these 'combined shopping trip' zones are conditional on the stores being positioned closely together, and gradually shrink with larger between-store distances.

6. Discussion, limitations and future research

In line with previous indications in the literature, we find that (i) the majority of consumers regularly visits more than one store for grocery purchases, (ii) sales promotions alone do not explain why consumers engage in multiple-store shopping, and (iii) many store 'switches' appear to be a rather regular sequence of multiple store visits. To our knowledge, this paper is the first to provide a comprehensive and formal analysis of why and how customers divide their grocery purchases over different stores on a systematic basis. By considering (i) shopping benefits as well as costs, (ii) store choice as well as visit frequency and category purchase allocations, and (iii) overall as well as category-specific store features, we provide a more complete and more accurate account of systematic multiple store shopping motivations and shopping patterns.

Motives for systematic (non-promotion based) multiple store shopping. Our research reveals that - even in the absence of promotions - consumers may have good reasons for shopping multiple grocery

stores. In particular, we find that grocery outlets may only become part of a multiple store strategy if they exhibit fixed cost complementarity or category preference complementarity.

First, patronizing stores with *different fixed shopping costs* may be an appealing compromise strategy between exclusively shopping in either of these stores alone. This is true even if one store offers better value for all categories, provided that (i) there is preference asymmetry –the degree of store preference differs across categories and (ii) there is a ‘total cost conflict’- the high unit variable cost store having the lower unit fixed cost. We refer to this case as ‘fixed cost complementarity’. By purchasing the more strongly preferred categories primarily in the high fixed cost store, but organizing in-between visits for the other categories in the low fixed cost store, the consumer may achieve the ‘best of both worlds’.

Second, we show that multiple store shopping may also be triggered by *category preference complementarity* - each store being preferred for at least one of the product categories. By systematically buying products in the store where they are most attractive, consumers can minimize their total variable shopping costs.

MSS trip organization. Our research establishes a link between these motives and the way shopping trips are organized. With fixed cost-complementarity, stores are always visited on separate shopping trips. With category preference complementarity, consumers may also engage in combined shopping trips, and the choice between separate versus combined store visits presents an interesting trade off between fixed and variable shopping costs. On the one hand, combined visits allow the consumer to save on transportation costs per trip and purchase each product exclusively in the store where it is preferred. When the stores are visited on separate trips, however, the number of trips per store can differ, and trips to different stores can be spread in time. This allows the consumer to purchase high holding cost categories on a more frequent basis, shifting some portion of the categories’ purchases to the less preferred store.

Patterns of Spatial Competition between grocery stores. Empirical results obtained from a scanner panel data set support the descriptive validity of our shopping cost model (and its implied complementarities), and allow to picture its implications for the spatial competition between store chains. Specifically, we identify three prototypical types of store competition: ‘Winner Takes All’

competition - each consumer being loyal to one store, ‘Partial Eclipse Competition’, where at least a fraction of consumers - situated between the stores - will patronize both stores on separate visits, and ‘Jig-Saw Competition’ with designated zones of consumers engaging in single store shopping, separate store shopping and combined store shopping strategies. These competitive patterns offer important insights for retailers: depending on the store’s characteristics compared with local competitors, the retailer may find it more appropriate to pursue complete loyalty among a subset of consumers, or to make the most out of ‘cohabiting’ with these competitors by even encouraging MSS shopping. Store complementarities – and hence the prevailing competitive pattern – appear to be linked to store format. In particular, our empirical results suggest that fixed cost complementarity is more likely to occur between large discounters (with high in-store fixed costs and low unit variable costs especially for convenience categories) on the one hand and supermarkets or superstores (which, due to their pleasant ambience, entail low in-store fixed costs, coupled with an appealing offer for fresh and specialty items) on the other. For these store pairs, separate visit-multiple store shopping, where major trips alternate with fill-in trips to replenish high storage cost categories) is bound to occur. At the same time, we find evidence of category preference complementarity between hard discounters and supermarkets, and among supermarkets. This may encourage consumers to selectively buy different categories in these different stores, either on separate or combined trips. Absolute and inter-store distances appear to play a crucial role in the choice between the two multiple store shopping strategies, separate visits being more likely in the stores’ intersecting zone and combined shopping trips in the more distantly located border zone (where – depending on the inter-store distance – the additional fixed costs of combined visits may become relatively small).

Limitations and Future Research. Clearly, this research exhibits limitations, and leaves ample opportunities for future research. First, our formal model is stylised, focusing on multiple store shopping patterns involving two stores. Analysing patterns including three or more stores may be an interesting research avenue. Second, the stores considered are food-oriented retail outlets, essentially carrying the same assortment. Considering a broader set of retail formats may add to the complexity of the shopping decision process – which may become single as well as multiple purpose – yielding

additional insights into multiple store shopping motivations. Third, our shopping model describes consumers as fully informed, rational decision makers, with fixed category demand and able to perfectly plan their consumption ahead. Interesting extensions of our model would be to include the possibility of category consumption expansion, impulse purchases, and urgent/unplanned trips. These will add to the realism of our model, and may uncover additional motives for multiple store shopping. Fourth, given our focus on *systematic* multiple store shopping, we consider a ‘stable’ setting, leaving out the impact of temporary promotions. This allows us to isolate non-promotional motives triggering multiple store shopping. Adding the effect of promotional strategies to our equilibrium model will lead to an even richer representation of consumer shopping behavior, indicating how opportunistic - promotion-based - store switching interacts with MSS. Fifth, like most previous store choice papers, we use simple cost specifications. Introducing thresholds/nonlinearities like storage space constraints, the purchase of discrete package sizes, and time-dependent transaction costs would be a fruitful extension of our model. Finally, while the main focus in this paper is on optimal shopping patterns from the consumer’s viewpoint, an important next step will be the development of normative retailer models accommodating consumers’ MSS shopping behavior.

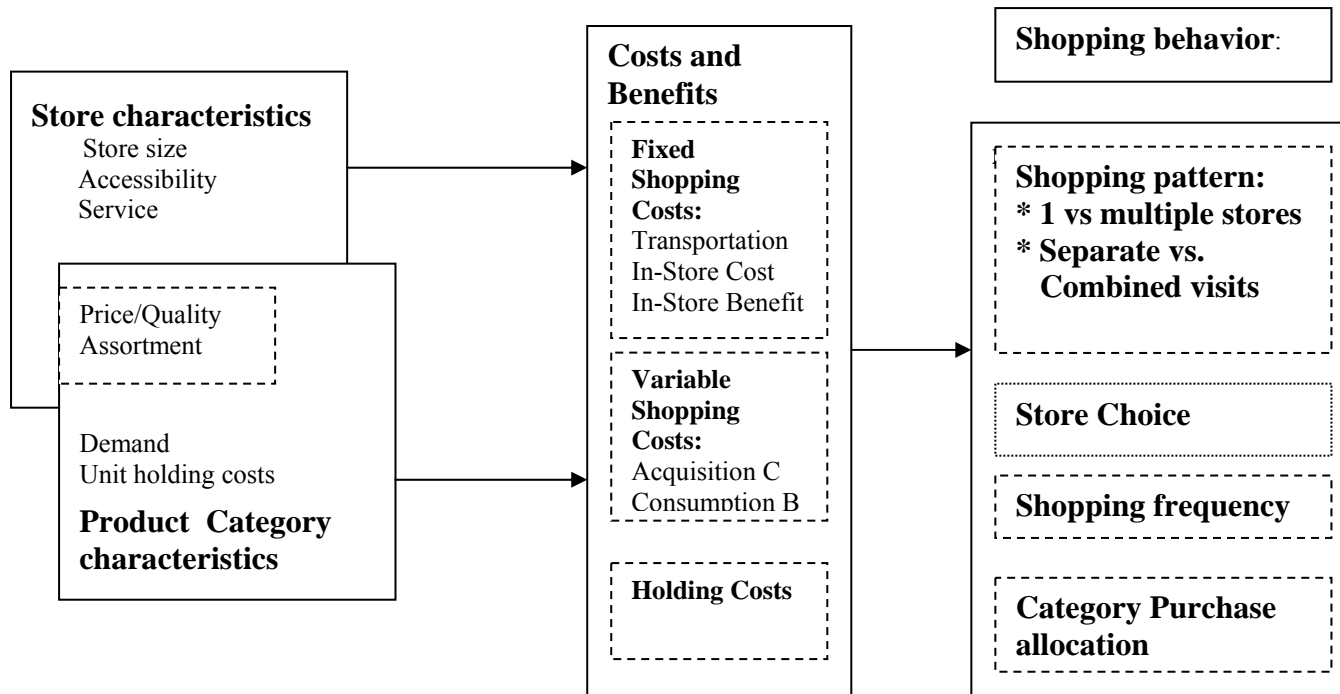


Figure 1: Conceptual Framework

Figure 2: Store (pair) characteristics and MSS patterns

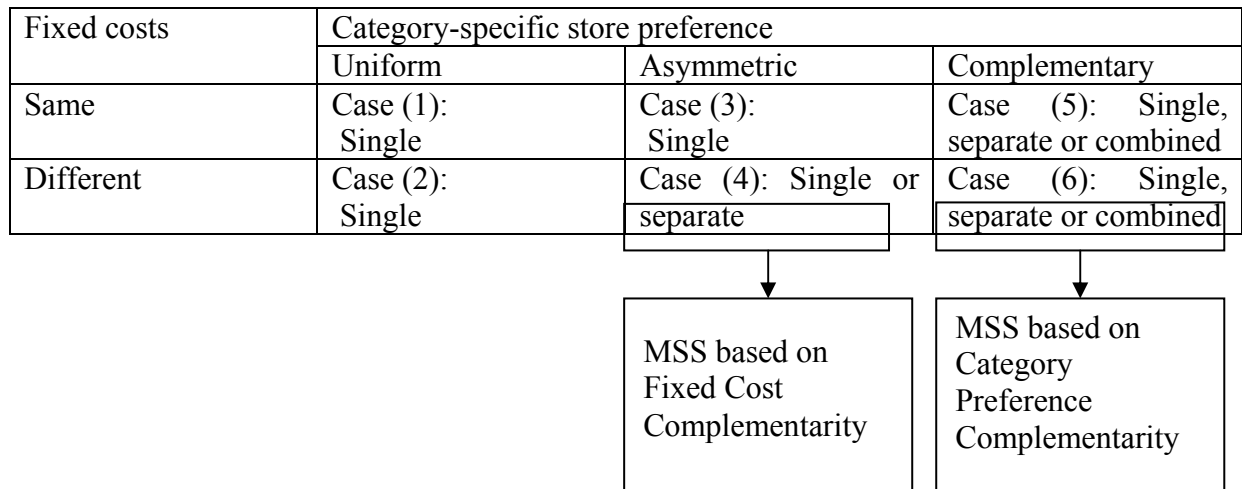


Figure 3: ‘Winner-Takes-All’ Competition

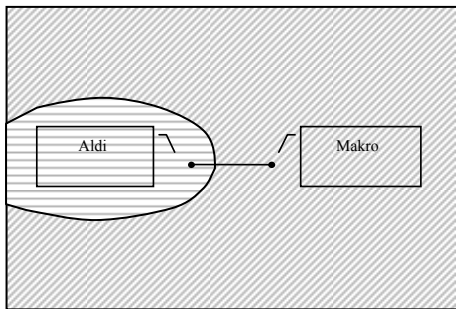


Figure 4: ‘(Partial)-Eclipse’ Competition

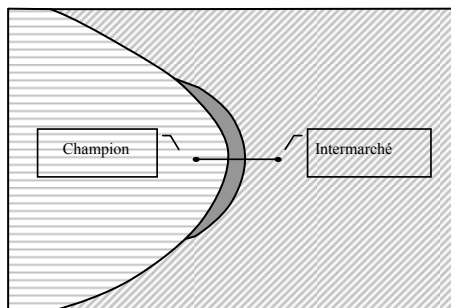


Figure 5: ‘Jig-Saw’ Competition

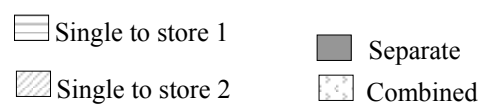
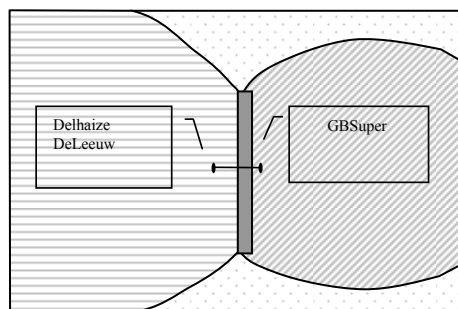


Table 1: Minimum Total Cost and Optimal decisions

Pattern	Number of Trips	Category Allocation	Total Cost*
Single Store (I)	$N_{s1} = \sqrt{(S_{p1}D_{p1} + S_{p2}D_{p2})/2t_{s1}}$	$\alpha_{I,p2,s1} = 1 \quad \alpha_{I,p1,s1} = 1$	$TC_{I,s1}^* = \sqrt{2t_{s1}(S_{p1}D_{p1} + S_{p2}D_{p2})}$ $+ D_{p1}VC_{p1,s1} + D_{p2}VC_{p2,s1}$
Separate Stores (II), stores s1 and s2	$N_{s1} = \sqrt{(S_{p1}D_{p1}\alpha_{II,p1,s1}^2 + S_{p2}D_{p2}\alpha_{II,p2,s1}^2)/2t_{s1}}$ $N_{s2} = \sqrt{(S_{p1}D_{p1}(1-\alpha_{II,p1,s1})^2 + S_{p2}D_{p2}(1-\alpha_{II,p2,s1})^2)/2t_{s2}}$	$\alpha_{II,p1,s1} = 1$ if $I_{p1,s1-s2} > 1/N_{s1}$ $\alpha_{II,p1,s1} = 0$ if $I_{p1,s1-s2} < -1/N_{s2}$ $\alpha_{II,p1,s1} = \frac{I_{p1,s1-s2} + 1/N_{s2}}{1/N_{s1} + 1/N_{s2}}$ <i>otherwise</i>	$TC_{II,s1-s2}^* = \sqrt{2t_{s1}(S_{p1}D_{p1}\alpha_{II,p1,s1}^2 + S_{p2}D_{p2}\alpha_{II,p2,s1}^2)} +$ $\sqrt{2t_{s2}(S_{p1}D_{p1}(1-\alpha_{II,p1,s1})^2 + S_{p2}D_{p2}(1-\alpha_{II,p2,s1})^2)} +$ $D_{p1}(VC_{p1,s1}\alpha_{II,p1,s1} + VC_{p1,s2}(1-\alpha_{II,p1,s1}))$ $+ D_{p2}(VC_{p2,s1}\alpha_{II,p2,s1} + VC_{p2,s2}(1-\alpha_{II,p2,s1}))$
Combined Stores (III)	$N_{s1s2} = \sqrt{(S_{p1}D_{p1} + S_{p2}D_{p2})/2t_{s1s2}}$	$\alpha_{III,p1,s1} = 1$ if $I_{p1,s1-s2} > 0$, and $\alpha_{III,p1,s1} = 0$ otherwise. $\alpha_{III,p2,s1} = 1$ if $I_{p2,s1-s2} > 0$, and $\alpha_{III,p2,s1} = 0$ otherwise.	$TC_{III,s1-s2}^* = \sqrt{2t_{s1s2}(S_{p1}D_{p1} + S_{p2}D_{p2})}$ $+ D_{p1}(\alpha_{III,p1,s1}VC_{p1,s1} + (1-\alpha_{III,p1,s1})VC_{p1,s2})$ $+ D_{p2}(\alpha_{III,p2,s1}VC_{p2,s1} + (1-\alpha_{III,p2,s1})VC_{p2,s2})$

Table 2: Glossary of key terms linked to MSS Motivations

Term	Description	Specification
Category-specific store preference for product p1 in store s1 compared to store s2	The difference between product p1's unit variable cost, divided by its unit holding cost, in store s2 and store s1	$I_{p1,s1-s2} = \frac{(VC_{p1,s2} - VC_{p1,s1})}{S_{p1}}$ <p>If greater than 0, store s1 is preferred over store s2 for product p1</p>
Uniform category preferences	Based on variable costs divided by holding costs, one store may be preferred over the other for both categories, but the difference in store preference is the same for all categories	$I_{p1,s1-s2} = I_{p2,s1-s2}$
Category preference asymmetry	Based on variable costs divided by holding costs, one store is preferred over the other for both categories, but the difference in store preference is greater for one category than for the other	$I_{p1,s1-s2} \cdot I_{p2,s1-s2} > 0$ <p>and</p> $I_{p1,s1-s2} \neq I_{p2,s1-s2}$
Category preference complementarity	Based on variable costs divided by holding costs, one store is preferred over the other for one category, but the other store is preferred for the second category	$I_{p1,s1-s2} \cdot I_{p2,s1-s2} < 0$
Strong category preference complementarity	Based on variable costs divided by holding costs, each store is preferred for one of the categories. In addition, cat.spec.store preferences are sufficiently strong, so that each category will exclusively be purchased in the most preferred store ($\alpha=1$ or 0).	$I_{p1,s1-s2} \cdot I_{p2,s1-s2} < 0$ <p>and</p> $I_{p1,s1-s2} > 1/N_{s1}^*$ <p>N_{s1}^* represents the lowest optimal number of trips per period to store s1 under all possible shopping patterns including store s1</p>
Total cost conflict	One store offers the lowest fixed costs, the other store the lowest variable costs.	$t_{s1} > t_{s2}$ $\sum_p D_p VC_{p,s1} < \sum_p D_p VC_{p,s2}$

Table 3: Overview of explanatory variables

Variable	Operationalization
p	Product indicator. Product categories are classified as either convenience, (p=1), specialties (p=2) or fresh products (p=3).
D_p^h	Demand for product p by household h over a one month period, expressed in monetary units (100 Euros) based on the average category prices across stores.
S_p	Storage cost per unit for category p over a one month period. $S_p = \sigma * SI_p$ where σ represents the base level and SI_p a category-specific multiplier (set to one for convenience and specialty products, and estimated for fresh products).
t_{s1}^h	Net fixed cost incurred per trip to the store s_i for household h. $t_{s1}^h = I_{f,s1} + \beta Dist_{s1}^h$ where $I_{f,s1}$ represents the store format indicator, equal to one if store (chain) s_i belongs to format f (Hard discounter, Large discounter, Superstore, Supermarkets) and zero elsewhere and $Dist_{s1}^h$ is the distance between household h's residence and the closest store (chain) s_i , expressed in kilometres.
VC_{p,s_i}	Net variable cost per unit of category p in store s_i . $VC_{p,s_i} = PI_{p,s_i} - VBI_{p,s_i}$ where PI_{p,s_i} represents the price index for product p in store s_i , defined as the store 's own unit price for the product, relative to the average product unit price across stores and VBI_{p,s_i} is the Index for 'variable benefits' per unit (100 Euro) spent on product p in store s_i . $VBI_{p,s_i} = QI_{p,s_i} * (Size_s)^\kappa$, where QI_{p,s_i} is a quality indicator for product p, store s_i , $Size_s$ reflects store surface and κ is a parameter.

Table 4. Estimation Results

Parameter	Base Sample		Bootstrap: (500 samples)	
	Mean	SD	Mean	SD across samples
β (Distance)	.329	.068	.334	.040
Variable Benefit :				
γ (Quality)	-1.325	.475	-1.256	.054
κ (Assortment Size)	.104	.042	.109	.016
SI_{fresh} (Holding Cost Index Fresh)	2.519	.872	2.559	.048
In-store Fixed Cost :				
δ_{HD} (Hard Discounter)	.994	.234	1.210	.226
δ_{LD} (Large Discounter)	1.438	.357	1.487	.094
δ_{SS} (Superstore)	-.016	.054	-.034	.088

Table 5: Net Variable costs by category type for different chains

Chain	Format	Unit Variable Cost Index divided by Unit Holding Cost Index ($PI_{p,s} - VBI_{p,s}$)/ SI_p		
		Convenience	Specialties	Fresh
Aldi	Hard discounter	-.231	-.163	-.0312
Champion	Supermarket	-.187	-.211	-.103
Colruyt	Large discounter	-.480	-.546	-.206
Cora	Superstore	-.342	-.382	-.146
DelhaizeAD	Supermarket	-.157	-.194	-.073
DelhaizeDL	Supermarket	-.132	-.163	-.068
GBMaxi	Superstore	-.212	-.122	-.081
GBSuper	Supermarket	-.147	-.111	-.050
GBSuperpartner	Supermarket	-.164	-.155	-.065
Intermarché	Large discounter	-.390	-.392	-.156
Lidl	Hard discounter	-.230	-.178	-.065
Makro	Large discounter	-.390	-.449	-.173

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Appendix 1: Derivation of optimal category purchase allocations, number of trips, and optimal total cost

A.1.1. Optimal Category Purchase Allocations

For each multiple store shopping pattern, optimal category purchase allocations (expressions for $\alpha_{p,s}$) are derived conditional upon store visit frequencies (N_s).

Shopping Pattern II: separate visits to store s1 (N_{s1} visits) and store s2 (N_{s2} visits).

Computing the first order derivative of total costs in equation (1b) wrt $\alpha_{p,s1}$ and setting it equal to zero leads to the following expression:

$$\frac{\partial TC}{\partial \alpha_{p,s1}} = VC_{p,s1} D_p - VC_{p,s2} D_p + 2\alpha_{p,s1} S_p D_p / 2N_{s1} - 2(1 - \alpha_{p,s1}) S_p D_p / 2N_{s2} = 0 \quad (A1)$$

implying that:

$$\alpha_{p,s1}^* = \left[(-VC_{p,s1} + VC_{p,s2}) / S_p + 1/N_{s2} \right] / (1/N_{s1} + 1/N_{s2})$$

$$\text{or, letting } I_{p,s1-s2} = \frac{(VC_{p,s2} - VC_{p,s1})}{S_p},$$

$$\alpha_{p,s1}^* = \left[I_{p,s1-s2} + 1/N_{s2} \right] / (1/N_{s1} + 1/N_{s2}) \quad (A2)$$

From the above expression (A1), it is clear that the second derivative wrt $\alpha_{p,s1}$ is positive – such that the second order optimality condition is satisfied. Furthermore, given the requirement that $0 \leq \alpha_{p,s1}^* \leq 1$, a necessary

condition for this allocation to be meaningful is

$$\left[(-VC_{p,s1} + VC_{p,s2}) / S_p = I_{p,s1-s2} < 1/N_{s1} \right] \quad (A3a)$$

and

$$\left[(-VC_{p,s1} + VC_{p,s2}) / S_p > -1/N_{s2} \right] \quad (A3b)$$

If (A3a) is violated, it follows that $\alpha_{p,s1}^* = 1$: it is optimal to purchase all of category p in store s1. Conversely, violation of (A3b) implies that $\alpha_{p,s1}^*$ must be set at the lower boundary ($\alpha_{p,s1}^* = 0$), such that all of D_p is bought in store s2.

A.1.2. Optimal Trip Planning

Knowing the optimal category purchase allocations, we can now derive – for each shopping pattern - the cost-minimizing number of shopping trips to the selected stores.

Pattern I (single store shopping)

The simplest case is that where only one store –say, store s1- is selected and visited repeatedly (*pattern I*).

Setting the first order derivative of total costs (equation (1a)) wrt N_{s1} equal to 0, and noting that the second order derivative is positive, immediately implies the following cost-minimizing number of trips to store s1:

$$N_{s1}^* = \sqrt{(S_{p1} D_{p1} + S_{p2} D_{p2}) / 2t_{s1}}$$

Substituting this expression in the total cost function and rearranging terms yields the minimum total cost for pattern I:

$$TC_{I,s1}^* = \sqrt{2t_{s1} (S_{p1} D_{p1} + S_{p2} D_{p2})} + D_{p1} VC_{p1,s1} + D_{p2} VC_{p2,s1}$$

where the first term is the sum of the optimal total holding and fixed cost, and the second term indicates the total variable cost.

Pattern II (multiple store shopping with separate visits)

Next, consider the case of *separate visits to stores s1 and s2 (pattern II)*, where optimal values for N_{s1} and N_{s2} have to be determined.

Let us first consider the case where the optimal category purchase allocations are given by:

$$\alpha_{p1,s1}^* = \left[I_{p1,s1-s2} + 1/N_{s2} \right] / (1/N_{s1} + 1/N_{s2}) \text{ and } \alpha_{p2,s1}^* = \left[I_{p2,s1-s2} + 1/N_{s2} \right] / (1/N_{s1} + 1/N_{s2}).$$

The derivative of [1b] wrt N_{s1} then becomes:

$$\begin{aligned} \frac{\partial TC}{\partial N_{s1}} &= \sum_{p=p1,p2} (\partial \alpha_{p,s1} / \partial N_{s1}) [VC_{p,s1} - VC_{p,s2}] D_p \\ &+ \partial \alpha_{p,s1} / \partial N_{s1} \cdot [\alpha_{p,s1} S_p D_p / N_{s1} - (1 - \alpha_{p,s1}) S_p D_p / N_{s2}] - \alpha_{p,s1}^2 S_p D_p / 2N_{s1}^2 + t_{s1} \end{aligned} \quad (A4)$$

It is easy to show that under the conditions just specified:

$$\partial \alpha_{p1,s1} / \partial N_{s1} = (\alpha_{p1,s1} / N_{s1}) \cdot ((1 / N_{s2}) / (1 / N_{s2} + 1 / N_{s1}))$$

Moreover, we can write:

$$[VC_{p1,s1} - VC_{p1,s2}]D_{p1} = -D_{p1}S_{p1}I_{p1,s1-s2} = -D_{p1}S_{p1}(\alpha_{p1,s1}(1/N_{s1} + 1/N_{s2}) - 1/N_{s2})$$

Substituting both of these expressions in (A4) and setting the result to zero leads – after some tedious calculations- to the following first order condition:

$$\sum_{p=p1,p2} \left[-S_p D_p \alpha_{p,s1}^2 / 2N_{s1}^2 \right] + t_{s1} = 0$$

implying that the optimal number of trips to store s1 is given by

$$N_{s1}^* = \sqrt{(S_{p1}D_{p1}\alpha_{p1,s1}^2 + S_{p2}D_{p2}\alpha_{p2,s1}^2) / 2t_{s1}}$$

The computations for N_{s2}^* are completely similar.

Substitution of these optima in the total cost function then yields:

$$TC_{II}^* = \sqrt{2t_{s1}(S_{p1}D_{p1}\alpha_{p1,s1}^2 + S_{p2}D_{p2}\alpha_{p2,s1}^2)} + \sqrt{2t_{s2}(S_{p1}D_{p1}(1-\alpha_{p1,s1})^2 + S_{p2}D_{p2}(1-\alpha_{p2,s1})^2)} + (VC_{p1,s1}\alpha_{p1,s1} + VC_{p1,s2}(1-\alpha_{p1,s1}))D_{p1} + (VC_{p2,s1}\alpha_{p2,s1} + VC_{p2,s2}(1-\alpha_{p2,s1}))D_{p2}$$

where the first two terms now indicate the total fixed plus holding costs incurred through the visits to stores s1 and s2, resp.

Note that the optimal category allocations in (A2) were derived for each category independently - assuming that store visit timing can be tailored to each separate category. With two product categories, this is true as long as $\alpha_{p1,s1}=1$ for at least one category and store. In that case, the optimal cost expressions reduce to:

$$TC_{II}^* = \sqrt{2t_{s1}(S_{p1}D_{p1} + S_{p2}D_{p2}\alpha_{p2,s1}^2)} + \sqrt{2t_{s2}(S_{p2}D_{p2}(1-\alpha_{p2,s1})^2)} +$$

$$VC_{p1,s1}D_{p1} + (VC_{p2,s1}\alpha_{p2,s1} + (1-\alpha_{p2,s1})VC_{p2,s2})D_{p2}$$

if category p1 is bought exclusively in store s1 while category p2 is spread across stores, or to:

$$TC_{II}^* = \sqrt{2t_{s1}S_{p1}D_{p1}} + \sqrt{2t_{s2}S_{p2}D_{p2}} + VC_{p1,s1}D_{p1} + VC_{p2,s2}D_{p2}$$

if p1 is bought exclusively in s1, and p2 exclusively in s2.

However, if the optimal expressions in (A2) are strictly between zero and one for both categories (purchases for each category are spread across stores), these optima may not be simultaneously implementable or reconcilable into one shopping strategy. The reason is that, unless $\alpha_{p1,s1}=\alpha_{p2,s1}$, each ‘optimal’ category allocation would correspond to a different timing of (the same N_{s1} and N_{s2}) shopping trips. Under those circumstances, the shopping costs derived above constitute a lower bound on the true (optimal) costs of a separate store visit strategy. Moreover, for the separate visit strategy to become implementable, adjustments need to be made in the categories’ purchase allocation and in the corresponding timing of store visits (an issue likely to become more important as the number of categories increases). The need for, and nature of these adjustments, is taken up in Appendix 3.

Pattern III (multiple store shopping with combined visits)

It is easy to see that the derivations for *pattern III (combined visits only)* are completely comparable to those for the single store pattern but where, now, the unit fixed cost is that of the combined trip (t_{s1s2} instead of t_{s1}), and categories are purchased in their preferred store (e.g. category p1 in store s1, category p2 in store s2):

$$N_{s1s2}^* = \sqrt{(S_{p1}D_{p1} + S_{p2}D_{p2}) / 2t_{s1s2}}$$

After substitution in the total cost expression, the corresponding minimal cost is easily found to be:

$$TC_{III}^* = \sqrt{2t_{s1s2}(S_{p1}D_{p1} + S_{p2}D_{p2})} + D_{p1}VC_{p1,s1} + D_{p2}VC_{p2,s2}$$

Appendix 2. Optimal shopping pattern selection

Proof of Result 1b.

If store preference is the same for both categories ($I_{p1,s1-s2} = I_{p2,s1-s2}$), strategy II will never be retained.

Indeed, under those conditions, we have $\alpha_{II,p1,s1} = \alpha_{II,p2,s1} = \alpha_{s1}$, and –based on Table 1–

$$TC_{II,s1-s2}^* = \alpha_{s1} TC_{I,s1}^* + (1 - \alpha_{s1}) TC_{I,s2}^*.$$

The total cost of the separate store strategy II, being a weighted average of the total costs of single strategies involving stores s1 and s2, can never be lower than each of these costs. Hence, with the same level of category preferences for store s1 in both categories, the separate store strategy is not selected. Result 2a further demonstrates that combined shopping patterns cannot be optimal either, implying that single store shopping patterns will always be preferred over MSS patterns in the case of uniform category-specific store preferences.

Proof of Result 2b.

Let store s1 be preferred over s2 for both categories ($I_{p1,s1-s2} > 0$ and $I_{p2,s1-s2} > 0$), but have fixed shopping costs t_{s1} that are different from store s2 (t_{s2}). Following result 2a, shopping pattern III will never be optimal when there is no category preference complementarity. Hence, the consumer's choice is limited to visiting store s1 alone, store s2 alone, or both stores on separate visits.

Let us, first, consider the case where $t_{s1} < t_{s2}$.

It is clear that the cost of visiting store s1 alone is lower than that of visiting only store s2:

$$TC_{I,s1}^* = \sqrt{2t_{s1}(S_{p1}D_{p1} + S_{p2}D_{p2})} + D_{p1}VC_{p1,s1} + D_{p2}VC_{p2,s1}$$

$$< TC_{I,s2}^* = \sqrt{2t_{s2}(S_{p1}D_{p1} + S_{p2}D_{p2})} + D_{p1}VC_{p1,s2} + D_{p2}VC_{p2,s2}$$

and lower than that of visiting both stores on separate trips:

$$TC_{I,s1}^* = \sqrt{2t_{s1}(S_{p1}D_{p1} + S_{p2}D_{p2})} + D_{p1}VC_{p1,s1} + D_{p2}VC_{p2,s1} <$$

$$TC_{II}^* = \sqrt{2t_{s1}(S_{p1}D_{p1}\alpha_{II,p1,s1}^2 + S_{p2}D_{p2}\alpha_{II,p2,s1}^2)} + \sqrt{2t_{s2}(S_{p1}D_{p1}(1 - \alpha_{II,p1,s1})^2 + S_{p2}D_{p2}(1 - \alpha_{II,p2,s1})^2)} + (VC_{p1,s1}\alpha_{II,p1,s1} + VC_{p1,s2}(1 - \alpha_{II,p1,s1}))D_{p1} + (VC_{p2,s1}\alpha_{II,p2,s1} + VC_{p2,s2}(1 - \alpha_{II,p2,s1}))D_{p2}$$

since

$$I_{p1,s1-s2} > 0 \text{ implies that } VC_{p1,s1} < VC_{p1,s2} \text{ and } I_{p2,s1-s2} > 0 \text{ implies that } VC_{p2,s1} < VC_{p2,s2}$$

So: in the absence of a ‘total cost conflict’ ($I_{p1,s1-s2} > 0$ and $I_{p2,s1-s2} > 0$ and $t_{s1} < t_{s2}$), the separate store strategy is ruled out. The optimal strategy remains a single store strategy with store s1.

Second, consider the situation where $t_{s1} > t_{s2}$. In this case, there is a ‘total cost conflict’, the low variable cost store s1 having the higher unit fixed cost. The consumer must now weigh the two single store strategies (I) (only visit store s1 or store s2), and the separate multiple store visits strategy (II), against one another.

⇒ Comparing the two *single store strategies*, we know from Table 1 that store s1 will be selected as long as:

$$(\sqrt{t_{s1}} - \sqrt{t_{s2}})\sqrt{2(D_{p1}S_{p1} + D_{p2}S_{p2})} < D_{p1}S_{p1}I_{p1,s1-s2} + D_{p2}S_{p2}I_{p2,s1-s2} \quad (A5)$$

This condition may or may not hold, depending on the specific levels of t_{s1} , t_{s2} , $I_{p1,s1-s2}$ and $I_{p2,s1-s2}$. The choice of the best single store strategy involves a trade off between the fixed plus holding cost increase (left side of (A5)), and the variable cost decrease (right side of (A5)) from visiting store s1 rather than s2.

⇒ For the *separate store strategy* to be selected, we must have that

$$TC_{II,s1-s2}^* < TC_{I,s1}^* \text{ and } TC_{II,s1-s2}^* < TC_{I,s2}^* \quad (A6)$$

Whether these conditions hold depends on the levels of $I_{p1,s1-s2}$ and $I_{p2,s1-s2}$.

If $I_{p1,s1-s2} > 0$, $I_{p2,s1-s2} > 0$ and $I_{p1,s1-s2} \neq I_{p2,s1-s2}$, the total variable costs for strategy II hold the middle between those for the single store s1 and the single store s2 strategy:

$$D_{p1}VC_{p1,s2} + D_{p2}VC_{p2,s2} > D_{p1}VC_{p1,s1}\alpha_{II,p1,s1} + D_{p1}VC_{p1,s2}(1 - \alpha_{II,p1,s1})$$

$$D_{p2}VC_{p2,s1}\alpha_{II,p2,s1} + D_{p2}VC_{p2,s2}(1 - \alpha_{II,p2,s1}) > D_{p1}VC_{p1,s1} + D_{p2}VC_{p2,s1}$$

The total fixed plus holding costs for the multiple store strategy will certainly exceed those of store s2 when visited alone:

$$\sqrt{2t_{s1}(S_{p1}D_{p1}\alpha_{II,p1,s1}^2 + S_{p2}D_{p2}\alpha_{II,p2,s1}^2)} + \sqrt{2t_{s2}(S_{p1}D_{p1}(1-\alpha_{II,p1,s1})^2 + S_{p2}D_{p2}(1-\alpha_{II,p2,s1})^2)} \\ > \sqrt{2t_{s2}(S_{p1}D_{p1} + S_{p2}D_{p2})},$$

yet they *may* be lower than those for the single strategy with store s1

$$\sqrt{2t_{s1}(S_{p1}D_{p1}\alpha_{II,p1,s1}^2 + S_{p2}D_{p2}\alpha_{II,p2,s1}^2)} + \sqrt{2t_{s2}(S_{p1}D_{p1}(1-\alpha_{II,p1,s1})^2 + S_{p2}D_{p2}(1-\alpha_{II,p2,s1})^2)} < \\ \sqrt{2t_{s1}(S_{p1}D_{p1} + S_{p2}D_{p2})}$$

if the category with the higher holding cost potential (say, e.g. category p2) is less strongly preferred in the store with the higher unit fixed cost : $D_{p2}S_{p2} > D_{p1}S_{p1}$ and $I_{p2,s1-s2} < I_{p1,s1-s2}$ with $t_{s1} > t_{s2}$. In this case, the increase in total variable costs (from transferring part of the basket to store s2), may be more than compensated by the reduction in total fixed plus holding costs (by visiting the low unit fixed cost store s2 for purchases of the category with the weakest store preference for s1). This completes the proof of result 2b.

Proof of result 3a: Let stores be such that s1 is preferred for category p1 ($I_{p1,s1-s2} > 0$) and s2 for p2 ($I_{p2,s1-s2} < 0$).

We first consider the case with *equal unit fixed costs* ($t_{s1} = t_{s2} = t$).

\Rightarrow Comparing the two single store strategies with one another, we see from Table 1 that the consumer will select store s1 if

$$D_{p1}VC_{p1,s2} + D_{p2}VC_{p2,s2} > D_{p1}VC_{p1,s1} + D_{p2}VC_{p2,s1}$$

and store s2 in the opposite case.

\Rightarrow Comparing the single store strategies with the multiple store strategies leads to the following insights. The single store strategies will imply lower total fixed plus holding costs than any of the multiple store alternatives. Indeed, with $t_{s1} = t_{s2} = t < t_{s1s2}$, we have:

$$\sqrt{2t(S_{p1}D_{p1} + S_{p2}D_{p2})} \\ < \sqrt{2t(S_{p1}D_{p1}\alpha_{II,p1,s1}^2 + S_{p2}D_{p2}\alpha_{II,p2,s1}^2)} + \sqrt{2t(S_{p1}D_{p1}(1-\alpha_{II,p1,s1})^2 + S_{p2}D_{p2}(1-\alpha_{II,p2,s1})^2)} \\ < \sqrt{2t_{s1s2}(S_{p1}D_{p1} + S_{p2}D_{p2})}$$

where the comparisons are those with patterns II, and III, resp.

However, as the two stores are preference complements, patronizing both stores will allow to reduce total variable shopping costs. So, the selection of a single or a multiple store strategy depends on a trade off between lower total fixed plus holding costs, and lower total variable costs, resp.

\Rightarrow Comparing the costs of strategies II and III, we find that as long as category p1 is preferred in store s1 and p2 in s2, the total variable costs of strategy II are higher than those of strategy III:

$$D_{p1}VC_{p1,s1} + D_{p2}VC_{p2,s2} < D_{p1}VC_{p1,s1}\alpha_{II,p1,s1} + D_{p1}VC_{p1,s2}(1-\alpha_{II,p1,s1}) \\ + D_{p2}VC_{p2,s1}\alpha_{II,p2,s1} + D_{p2}VC_{p2,s2}(1-\alpha_{II,p2,s1})$$

However, the total fixed plus holding costs of strategy II, given by:

$$\sqrt{2t(S_{p1}D_{p1}\alpha_{II,p1,s1}^2 + S_{p2}D_{p2}\alpha_{II,p2,s1}^2)} + \sqrt{2t(S_{p1}D_{p1}(1-\alpha_{II,p1,s1})^2 + S_{p2}D_{p2}(1-\alpha_{II,p2,s1})^2)}$$

may or may not be lower than those of the combined strategy:

$$\sqrt{2t_{s1s2}(S_{p1}D_{p1} + S_{p2}D_{p2})}$$

depending on how category purchases are spread across the separate store visits. Hence, the selection between strategies II and III comes down to a trade off between (possibly) higher total fixed plus holding costs (for the combined strategy III) and higher total variable costs (for the separate store strategy II).

So, with category preference complementarity and equal unit fixed costs, none of the three shopping strategies (single store, multiple store-separate and multiple store-combined) can be ruled out a priori.

Second, in the more general case where the stores' unit fixed costs differ, the motives for selecting single, separate or combined strategies become a mixture of the motives underlying result 2 (no category preference complementarity and different unit fixed costs) and those described above (category preference complementarity and the same unit fixed cost). Introducing differences in unit fixed costs in the expressions above will reinforce the appeal of strategy II if the category with the higher holding cost potential is preferred in the store with the lower unit fixed cost. Conversely, if the category with the higher $S_{p1}D_{p1}$ is preferred in the high unit fixed cost store, the single (I) and combined (III) shopping patterns become relatively more appealing.

Appendix 3. Aligning category purchase allocations and store visit timing

To illustrate the 'alignment' problem with separate store visits, and several categories purchased in different stores, consider the following example.

Let $N_{s1}=1$, and $N_{s2}=2$. Assume (like in the simulations) that there are three categories, for which the independently optimal allocations (based on [A2]) amount to $\alpha_{1,s2}=0.25$, $\alpha_{2,s2}=0.5$ and $\alpha_{3,s2}=0.75$. It is easy to see that these optima are not reconcilable. Indeed, for category 1, visits to store s2 would have to take place as follows : if a visit to s1 occurs at time $t=0$, then store s2 would be visited at time .75 ($=1-\alpha_{1,s2}$) and .875 (store s2 visits being uniformly spread over the remaining period $\alpha_{1,s2}=0.25$, hence with inter-visit interval of $.25/N_{s2}=0.125$). For category 2, however, of which a larger portion is bought in store s2, the first visit to s2 would have to occur at time .50 already, and the second at time .75. Store timing for category 3, finally, would require visits to s2 at time .25 and .625. Obviously, as long as $N_{s2}=2$, these patterns are not reconcilable. We hypothesize that, to align store visit patterns across categories (and adjust purchase allocations accordingly), the consumer considers one of two options.

A first possibility is to let the most 'restrictive' category (of which most is bought in store s2) determine the timing of store s2 visits. In our example, this would be category 3. In that case, adjustments will have to be made to the purchase spread of categories 1 and 2. For these categories, the following options remain:

- (i) buy enough in store s1 to get by till the next visit to s2, then buy equal amounts on each visit to s2. This would come down to an allocation similar to that of category 3, with .25 of category needs bought in s1,
- (ii) skip one visit to s2, that is, buy enough in store s1 to last till the second visit to store s2, then purchase the remaining portion in store s2 on this second visit. The units bought in s1 would then have to cover a period equal to $(1-\alpha_{3,s2}) + \alpha_{3,s2}/N_{s2}$, where the first term represents time till the first visit to s2, the second term time between the first and the second visit to s2, leading to an 'adjusted' allocation to store s1 of 0.625.
- (iii) skip two visits to s2 which, in our example, results in purchasing everything from store s1

Which adjustment is optimal for category 1 and 2, will depend on the revised acquisition cost associated with the adjusted allocation, plus the revised holding cost implied by it. For category 2, the competing options seem to be (i) and (ii), while for category 1, options (ii) and (iii) are the best candidates. Note that – given $N_{s1}=1$ – the holding cost for the second option now comes down to $(1-\alpha_{3,s1})^2 S_p D_p / (2*(N_{s2}-1)) + (\alpha_{3,s1})^2 S_p D_p / (2)$, where the denominator of the first term indicates that one visit to store s2 is skipped.

A second possibility is that the consumer, in revising his allocation, determines a 'jointly optimal' alpha for all categories bought in store s2. (Such an alpha would be obtained by setting the derivative of the acquisition plus holding costs for categories 1 to 3 to zero, with respect to a joint alpha s1, similar to the step in Appendix 1.1. The formula is given below).

For instance, such a joint alpha for store s1 could amount to .4 (implying an alpha of .6 for store s2), in which case visits to store s2 would occur at time .4 and .7. For each of the three categories, and using a similar logic as before, the options would now be to

- (i) allocate .4 to store s1, and spread the remaining .6 over the two visits to s2
- (ii) allocate .7 to store s1, skip the first visit to s2, and purchase the remaining .3 on the last visit to s2
- (iii) buy everything in store s1

Again, for each product category, the best of these options will determine the adjusted purchase allocation for that category.

The consumer will then settle for the heuristic (either let the most restrictive category, or the joint alpha, determine store timing) that yields the lowest total cost.

In general, we adopt the following ‘procedure’ in our simulations. Let N_{s1} be the number of visits to store s1, and N_{s2} ($> N_{s1}$) the number of visits to s2, per period. Based on equation [A2], let the (unadjusted) category allocations be such that $\alpha_{p,s1} < 1$ for a subset of categories (in set Q1) and $\alpha_{p,s1} = 1$ for the remaining categories. We need to decide upon one (common) timing for the visits to store s2 (between subsequent visits to s1). Moreover, for all p in Q1, we need to adjust the levels of $\alpha_{p,s1}$ such that they are consistent with this store timing. Our procedure comprises the following steps:

- (1) For all categories in set Q1: determine a ‘common α_{s2} –candidate’: α_{s2}^c . Time visits to store s2 as follows: The first visit occurs $(1 - \alpha_{s2}^c)/N_{s1}$ periods after store s1 is visited, followed by $(N_{s2}/N_{s1}) - 1$ visits with inter-trip time of $\alpha_{s2}^c/(N_{s2})$
- (2) For each category in set Q1:
 - a. Consider all integer values x such that $\alpha_{p,s1|x}^c = (1 - \alpha_{s2}^c) + x (N_{s1}/N_{s2})$, $\alpha_{s2}^c \in [0, 1]$. Note that x represents the number of visits to store s2 that are ‘skipped’, see also the example above.
 - b. For each category: determine the level of x (x’) for which $D_p[VC_{p,s1}\alpha_{p,s1|x}^c + (1 - \alpha_{p,s1|x}^c)VC_{p,s2}] + (1 - \alpha_{p,s1|x}^c)^2 S_p D_p / (2(N_{s2} - xN_{s1})) + (\alpha_{p,s1|x}^c)^2 S_p D_p / (2N_{s1})$ is the lowest. Set $\alpha_{p,s1}^c = \alpha_{p,s1|x'}^c$, and $TC_p = D_p[VC_{p,s1}\alpha_{p,s1}^c + (1 - \alpha_{p,s1}^c)VC_{p,s2}] + (1 - \alpha_{p,s1}^c)^2 S_p D_p / (2(N_{s2} - x'N_{s1})) + (\alpha_{p,s1}^c)^2 S_p D_p / (2N_{s1})$
- (3) Sum TC_p across categories.
- (4) Repeat this procedure for the following α_{s2} –candidates’:
 - The maximum over categories in Q1, of their unadjusted $\alpha_{p,s2}$
 - A ‘jointly optimal’ level computed as:

$$\alpha_{s2}^c = (1 - \alpha_{s1}^c) = \left(1 - \frac{\frac{1}{N_{s2}} + \frac{\sum_{p \in Q_1} (VC_{p,s2} - VC_{p,s1}) D_p}{\sum_{p \in Q_1} S_p D_p}}{\frac{1}{N_{s2}} + \frac{1}{N_{s1}}}\right)$$

and select the ‘common α_{s2} –candidate’ that yields the lowest $\sum_p TC_p$. Implement the associated levels of $\alpha_{p,s1}^c$ and timing of visits to s2.

If $N_{s2} = N_{s1}$, repeat the procedure replacing s1 by s2. Then, select the adjusted strategy with the lowest $\sum_p TC_p$.